

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE			
4. PERFORMING ORGANIZATION REPORT NUMBER(S)		5. MONITORING ORGANIZATION REPORT NUMBER(S) NATICK/TR-88/060	
6a. NAME OF PERFORMING ORGANIZATION WORNICK SERVICES, INC.	6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION US ARMY NATICK RES DEV & ENG CENTER	
6c. ADDRESS (City, State, and ZIP Code) PO BOX 580308 HOUSTON, TX 77258-0308		7b. ADDRESS (City, State, and ZIP Code) NATICK, MA 01760-5018	
8a. NAME OF FUNDING/SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER DAAK60-87-C-0050	
8c. ADDRESS (City, State, and ZIP Code)		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO. 6.2	PROJECT NO. 1L162786
		TASK NO. AH99BC	WORK UNIT ACCESSION NO. 052
11. TITLE (Include Security Classification) PRODUCTION OF RETORTED MEALS IN COEXTRUDED BARRIER TRAYS (U)			
12. PERSONAL AUTHOR(S) KIMBERLY GLAUS LATE			
13a. TYPE OF REPORT FINAL REPORT	13b. TIME COVERED FROM <u>8-87</u> TO <u>1-88</u>	14. DATE OF REPORT (Year, Month, Day) 1988 FEBRUARY 5	15. PAGE COUNT 39
16. SUPPLEMENTARY NOTATION			

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)			
FIELD	GROUP	SUB-GROUP	MEALS	PACKAGING	THERMOPROCESSING	FEEDING
			FOOD	TRAYS	TEMPERATURE	MILITARY
			RETORT	POLYMERIZATION	MICROWAVE EQUIPMENT	

19. ABSTRACT (Continue on reverse if necessary and identify by block number)
The contract involves the production of individual servings of food packaged in microwavable polymeric trays and thermostabilized. These products were all packed in microwavable barrier polymeric trays for further study for their possible inclusion in military feeding programs. The items that were actually produced were as follows: Fruit Mix, Sliced Peaches, Sliced Pears, Chocolate Pudding, Potatoes au Gratin, Rice in Butter Sauce, Beef Stew, Beef Strips with Green Peppers and Gravy, Chicken a la King, Spaghetti with Meat Sauce.

The material used for the barrier trays was manufactured from a five-layer coextrusion of polypropylene, an adhesive layer, the barrier layer which is ethylene vinyl-alcohol (EVOH), an adhesive layer, and a final layer of polypropylene.

The lid material was a three-ply laminate consisting of polyolefin film, aluminum foil, and polyester.

(Cont'd.) - *[Signature]*

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL ANGELA FONG		22b. TELEPHONE (Include Area Code) (617) 651-4607
		22c. OFFICE SYMBOL STRNC-WTS

UNCLASSIFIED

C-1d

The equipment used to seal the trays was a Reycon 203 containermatic sealer. The report was a pilot-scale vertical retort.

The report shows the complete procedure for each product. This includes the Quality Control procedures and heat penetration and process determination.

Each product is produced according to the military specifications provided with the contract. In addition, the thermoprocessing time and temperature data of each product are reported.

Comments and recommendations are made by the technical advisor who was in charge of overseeing this project.

Keywords: food processing; food service;
food packaging; military rations; (KT)

UNCLASSIFIED

PREFACE

The following is a report on the performance of Contract DAAK60-87-C-0050. The contract was awarded to Wornick Services, Inc. and performed at Right Away Foods Corporation, MRE Division, in McAllen, Texas, under Project 1L162786AH99BC052.

Project Officer for contract was Nancy Kelley, later replaced by Angela Fong with Peter Burke as alternate Project Officer.

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	



TABLE OF CONTENTS

PREFACE.....	iii
LIST OF FIGURES.....	vii
LIST OF TABLES.....	vii
INTRODUCTION	
OBJECTIVES.....	1
MATERIALS.....	2
EQUIPMENT.....	3
MANUFACTURING METHODS	
QUALITY CONTROL.....	5
HEAT PENETRATION AND PROCESS DETERMINATION.....	6
FRUIT PRODUCTS.....	8
CHOCOLATE PUDDING.....	9
RICE IN BUTTER SAUCE.....	10
POTATOES AU GRATIN.....	11
CHICKEN A LA KING.....	13
BEEF STEW.....	14
BEEF STRIPS WITH GREEN PEPPER AND GRAVY.....	15
SPAGHETTI WITH MEAT SAUCE.....	16
RESULTS AND RECOMMENDATIONS.....	18
TABULATED SUMMARIES.....	18
DISCUSSION OF RESULTS WITH RECOMMENDATIONS	20
FRUIT PRODUCTS.....	20
CHOCOLATE PUDDING.....	20
RICE IN BUTTER SAUCE.....	21
POTATOES AU GRATIN.....	21
CHICKEN A LA KING.....	21
BEEF STEW.....	22
BEEF STRIPS WITH GREEN PEPPER AND GRAVY.....	22
SPAGHETTI WITH MEAT SAUCE.....	22
APPENDIX - PRODUCT FORMULAS	
A-1 FRUIT MIX.....	24
A-2 PEACH SLICES.....	25
A-3 PEAR SLICES.....	26
A-4 CHOCOLATE PUDDING.....	27
A-5 RICE IN BUTTER SAUCE.....	28
A-6 POTATOES AU GRATIN.....	29
A-7 CHICKEN A LA KING.....	30
A-8 BEEF STEW.....	31
A-9 BEEF STRIPS WITH GREEN BELL PEPPERS.....	32
A-10 SPAGHETTI WITH MEAT SAUCE.....	33
ABBREVIATIONS.....	35

LIST OF FIGURES

FIGURE 1	PILOT SCALE VERTICAL RETORT.....	3
FIGURE 2	TRAY ARRANGEMENT	4

LIST OF TABLES

TABLE 1	ACTUAL NET WEIGHTS OF MEAL COMPONENTS	18
TABLE 2	DRAINED WEIGHTS OF MEAL COMPONENTS	18
TABLE 3	RESULTS OF SALT AND FAT ANALYSIS ON SPECIFIC MEAL COMPONENTS	19
TABLE 4	BURST TEST RESULTS OF COEXTRUDED BARRIER TRAYS	19

PRODUCTION OF RETORTED MEALS IN COEXTRUDED BARRIER TRAYS

INTRODUCTION

OBJECTIVES

The project reported is based upon the idea that individual servings of food may be packaged in retortable polymeric trays and thermostabilized. The individual trays could then be combined in a larger tray to form a complete meal for an individual.

The objective of this contract is to supply Natick Research, Development and Engineering Center (Natick) with the following thermostabilized food items:

- Fruit Mix
- Sliced Peaches
- Sliced Pears
- Chocolate Pudding
- Potatoes au Gratin
- Rice in Butter Sauce
- Beef Stew
- Beef Strips with Green Peppers and Gravy
- Chicken a la King
- Spaghetti with Meat Sauce

These items will be packed in microwavable barrier polymeric trays for further study by Natick for their possible inclusion in military feeding programs.

U.S. Customary units of measurement are used in accordance with commercial equipment used in the industry.

MATERIALS

TRAY MATERIAL

The retortable barrier trays are manufactured from a five-layer coextrusion of polypropylene, an adhesive layer, the barrier layer which is ethylene vinyl alcohol (EVOH), an adhesive layer, and a final layer of polypropylene. The two sources used for the trays were DRG Plastics, Inc., Union, MO for the 10.5-ounce (oz) tray and Rampart Packaging, Inc., Williamsburg, VA for the 8-oz tray.

LID MATERIAL

The lidding material was supplied by American Can Co., Cleveland, OH and Reynolds (which was supplied to us by Nancy Kelley, the Natick Project Officer). The lidstock from American Can used to seal the Rampart 8 oz trays was a three-ply laminate consisting of 0.004-inch-(") thick polyolefin film, 0.00035"-thick aluminum foil, and 0.0005"-thick polyester.* The Reynolds material was used to seal the DRG trays and was a three-ply laminate consisting of 0.003-0.004"-thick polypropylene, 0.00035-0.0007"-thick aluminum foil, and 0.0005"-thick polyester.*

* The descriptions of the laminates are given from inside to outside.

EQUIPMENT

The trays were sealed with a Reycon 203 Containermatic Sealer. This sealer has a single chamber, and a skilled operator can seal up to two trays per minute. We had hoped to use the Mahaffy and Harder 1400 sealer, but unfortunately location changes and mechanical problems prevented us from using this faster piece of equipment.

The retort used is a pilot-scale, vertical retort, manufactured by Dixie Canner Equipment Company of Athens, GA. The retort (see Figure 1) was modified to accommodate both steam and water type cooks.

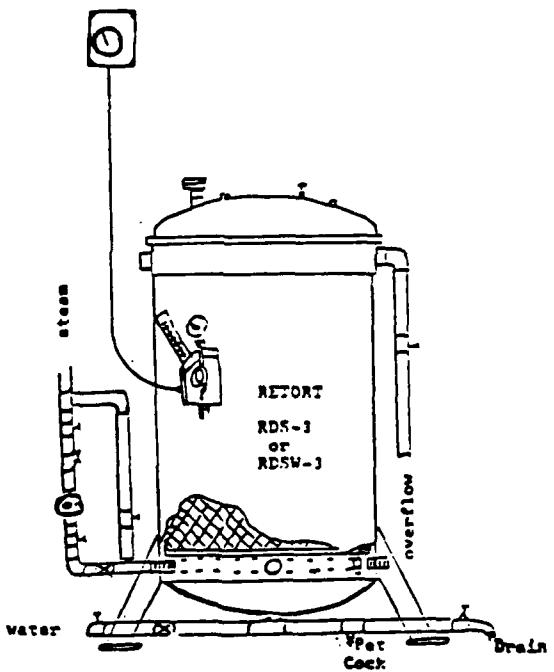


FIGURE 1. PILOT SCALE VERTICAL RETORT

The retort rack system used was constructed of stainless steel wire mesh and had fourteen layers. Each layer held either eighteen Rampart trays or ten DRG trays for respective totals of 252 8-oz Rampart trays or 140 10.5-oz DRG trays per load. The sealed trays were manually placed in the rack. The tray arrangement for both the Rampart and DRG trays is shown in Figure 2. The fully loaded rack was lifted into the retort using a hydraulic lift.

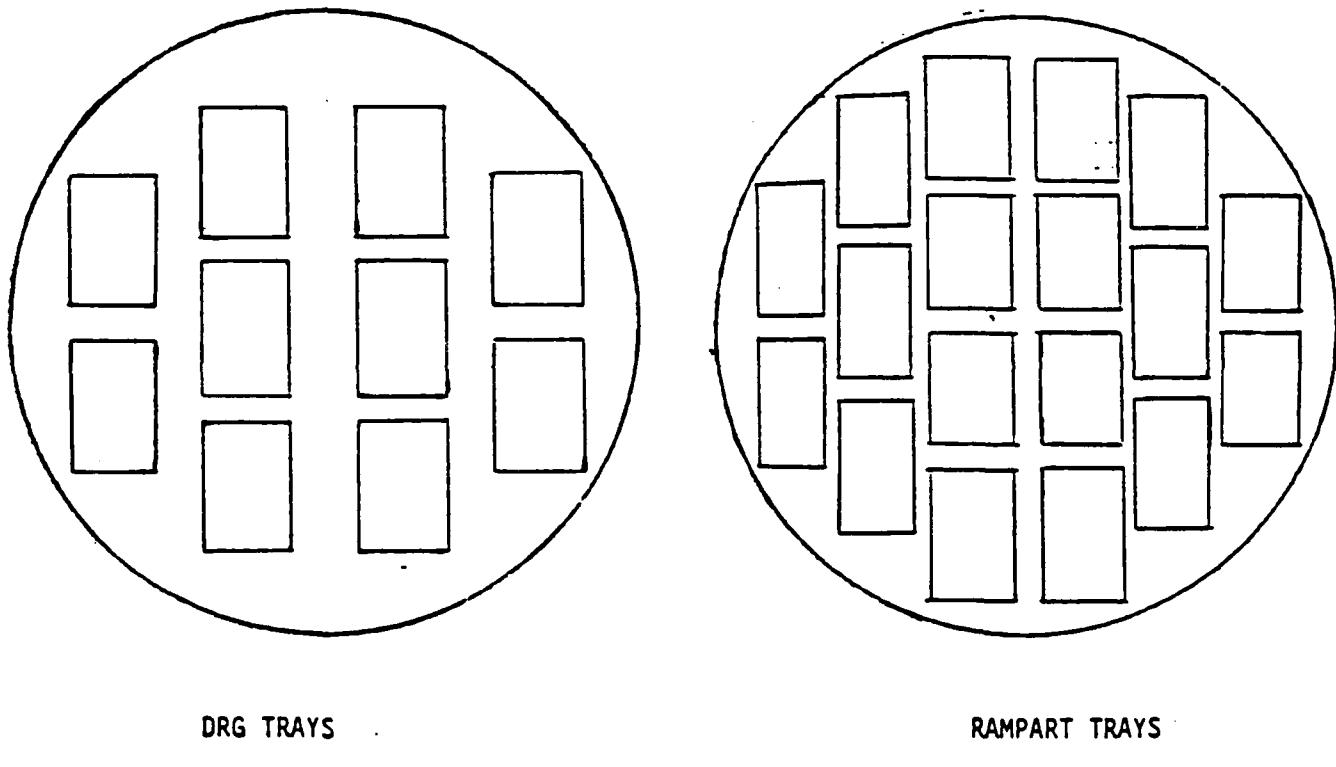


FIGURE 2. TRAY ARRANGEMENT

MANUFACTURING METHODS

QUALITY CONTROL PROGRAM

The quality control program implemented on this contract followed the guidelines previously set at Shelf Stable Foods, a certified retort pouch operation, for production of food items to be used in military feeding programs.

The quality assurance supervisor wrote batch sheets for each of the products, specifying amounts of ingredients to be weighed out for each batch size as well as instructions on how the ingredients were to be combined.

After the batch was complete, the quality assurance supervisor instructed the workers to manually fill the trays with the proper fill weights of the product and decided whether a one-stage or two-stage fill was required. As the filling procedure started, five samples were immediately pulled to check for net weights. If these were unacceptable, the filling was reviewed and the tare weight of the scale checked until five acceptable samples were obtained.

As principal investigator, the author of this report checked the parameters of the Reycon sealer and changed them when necessary. When filling procedures were determined to be satisfactory, three trays were sealed and checked for residual air (RA) content. If the RA of the tray was 10 cubic centimeters (cc) or less, the tray was acceptable. An RA reading over 10 cc was unacceptable, and the vacuum on the Reycon sealer was adjusted accordingly.

After the production line had been started, samples were pulled periodically to monitor the line. Net weights were checked by pulling five samples (sealed) every thirty minutes and returning them to the line. Drained weights were checked (prior to retorting) at the rate of three samples per hour. Samples were checked for RA at the rate of three samples every two hours if the results were satisfactory.

Post retort analysis of the products included salt and fat determination (performed at Shelf Stable Foods using Association of Official Analytical Chemists (AOAC) approved methods). Moisture analysis of the rice was performed at Right Away Foods Corporation, MRE Division (RAFCO MRE) using both Ohaus moisture balance and vacuum oven. The consistency of the chocolate pudding could not be measured due to lack of availability of a Bostwick Consistometer. In our sensory evaluation of the pudding, we felt it had the typical characteristics of a commercially acceptable pudding. The formulation used for each product is shown in the Appendix.

Incubation samples were pulled at the rate of two samples from each retort load of each product. The Fruit Mix, Sliced Peaches, and Sliced Pears were placed in an incubator set at 76 degrees Farenheit (76°F). The meat items, Chicken a la King, Potatoes au Gratin, Rice in Butter Sauce, and Chocolate Pudding were placed in a 100°F incubator. All products continued in incubation for twenty days at which time they were inspected for evidence of spoilage. When the products passed the incubation period, the finished product was palletized and shipped to Natick Research, Development and Engineering Center.

HEAT PENETRATION AND PROCESS DETERMINATION

The usual course of action in determining a retort process for a food item is to perform a series of heat penetration studies and provide the accumulated data to a recognized process authority who then sets the process required to ensure commercial sterility in the product. The process authority also files the process with the appropriate regulatory agency.

Because this contract contained small quantities of several products, the decision was made to include heat penetration trays with every retort load to monitor each process and ensure commercial sterility, as opposed to setting a process with a process authority. Thermocouples were mounted in trays to read the geometric center of the tray, and where possible a piece of product was impaled on the thermocouple.

The trays were placed throughout the rack to reflect the heating characteristics of all areas inside the retort. The process was monitored using a Kaye Digistrip II which had been programmed to measure lethality at any given minute as well as accumulate lethality throughout the cook. All process records were kept and documented by the Quality Assurance Supervisor.

FRUIT PRODUCTS

FRUIT PREPARATION

The manufacturing methods for the Fruit Mix, Sliced Peaches and Sliced Pears were virtually the same. The canned fruit was drained, the syrup was reserved and treated with ascorbic acid to increase the acidity level (pH) of the syrup so that the finished product pH would be less than 4.5.

FILLING AND SEALING

The drained fruit was weighed into 8-oz Rampart trays to the desired weight and the treated syrup was added to complete the fill. The fill weights used for each product were as follows:

<u>Product</u>	<u>Percentage By Weight</u>	<u>Actual Grams</u>
Fruit Mix		
fruit	64.0	146.0
syrup	36.0	81.0
	-----	-----
Total	100.0%	227.0 grams (g)
Sliced Peaches		
fruit	60.0	136.0
syrup	40.0	91.0
	-----	-----
Total	100.0%	227.0 g
Sliced Pears		
fruit	60.0	136.0
syrup	40.0	91.0
	-----	-----
Total	100.0%	227.0 g

Tray sealing parameters for the fruit products were as follows:

Vacuum: 24" mercury (Hg) (25" Hg on peaches only)
Seal Temperature: 400° F
Seal Time: 1.5 seconds
Seal Pressure: 60 pounds per square inch (psig)
Chamber dwell: 4.00 seconds

THERMOPROCESSING

Processing of the fruit products was done utilizing a steam cook in the retort to pasteurize the product. The retort process temperature was 220° F, the desired internal product temperature was 195° F. Retort cook cycles for the fruit products are as follows:

Fruit Mix: 13-17 minutes after retort reached process temperature
Peaches: 9-12 minutes after retort reached process temperature
Pears: 9-12 minutes after retort reached process temperature

CHOCOLATE PUDDING

PREPARATION

The chocolate pudding was produced in three batch sizes - 300 pounds (1b) and 200 lb, and 40 lb. The 300-lb batch took a long time to fill and seal, and it became very thick. The 200-lb batch was formulated in the 60-gallon steam-jacketed kettle using the lightening blender to combine the ingredients. The batch was heated to 185° F after the addition of the starch slurry and held for five minutes.

A second production run was produced in May 1988. The batches were weighted at 50 lb each. This smaller batch cooled down quicker and was easier to fill and seal. The end product was better in appearance, taste and texture.

FILLING AND SEALING

The product was filled into 8-oz Rampart trays, 250 g per tray. The fill weight was increased from 227 g to 250 g because the amount of headspace left in a 227 g fill was resulting in tray deformation when sealed with adequate vacuum to meet the RA requirements. The product temperature at the time of sealing was in the range of 110 to 130° F. The specification called for a prefill temperature of 150 to 180° F but the product could not be sealed at this temperature; it would "boil over" in the vacuum chamber when the pressure decreased.

Sealing parameters for chocolate pudding were as follows:

Vacuum:	23-24" Hg
Seal Temperature:	360° F
Seal Time:	1.5 seconds
Seal Pressure:	60 psig
Chamber Dwell:	4.00 seconds

THERMOPROCESSING

Processing of the chocolate pudding was done utilizing a water cook at 250° F. The product was processed to an accumulated lethality of 8.5 high, which is expressed as an Fo8.5. The cook cycles tended to be in the range of 28 to 35 minutes, one cycle was 23 minutes with a long come-up time, and one cycle was 40 minutes long.

RICE IN BUTTER SAUCE

PREPARATION

The rice in butter sauce was formulated in small quantities (12.5 lb of cooked rice to 432.1 g butter sauce) to achieve adequate mixing of the rice and butter sauce.

The rice was blanched in the five-gallon steam-jacketed tilt kettle for 12 minutes in 190° to 200° F water. After rinsing with cool water, the rice was drained and weighed.

The butter sauce was prepared in the five-gallon steam-jacketed tilt kettle. After the lecithin and butter were thoroughly blended, the salt was added and mixed well. It was difficult to dissolve the salt into this mixture, so it often had to be scraped out of the kettle.

The butter sauce was added to the rice and the product stirred manually to evenly distribute the butter sauce in the rice.

FILLING AND SEALING

Each tray of rice was filled in one stage and had to be packed down to meet the net weight requirement of 227 g. The trays used were the 8-oz Rampart trays.

Sealing parameters were as follows:

Vacuum:	22-24" Hg
Seal Temperature:	360° F
Seal Time:	2.00 seconds
Seal Pressure:	50 psig
Chamber Dwell:	4.00 seconds

THERMOPROCESSING

Processing of the rice was done utilizing water cooks at both 250° F and 240° F. Processing the product at 240° F yielded a lighter colored product, so that was the temperature used on the advice of Natick's Project Officer, Nancy Kelley. Retort cook cycles were 30 to 40 minutes at 250° F, 40 to 50 minutes at 240° F after retort reached process temperature. The sterilization requirement for this product was an F₀6.

POTATOES AU GRATIN

PREPARATION

Sauce for the potatoes au gratin was prepared by combining the starch with a portion of the formula water and setting aside. The remaining ingredients were added to the remaining formula water in the five-gallon steam-kettle and stirred continuously with a wire whip to mix and remove all lumps.

The starch slurry was added and stirred continuously. The sauce was brought to a temperature of 180 to 190°F and held for five minutes while stirring. The sauce was then weighed to determine what evaporation loss had occurred and the appropriate amount of water was added back to the sauce and stirred well to mix.

The potatoes were blanched in five-lb batches in 200 to 210°F water for three minutes. The potatoes were rinsed with cool water, drained and weighed to assure that proper hydration had occurred (1.5 times the original dry weight).

FILLING AND SEALING

The product was filled into 8-oz Rampart trays using a two stage fill. The product was filled in the following proportions:

<u>Ingredient</u>	<u>Percentage By Weight</u>	<u>Actual Grams</u>
Potatoes, blanched	35.0	80 g
sauce	65.0	148 g
Total	100.0%	228 g

The temperature of the sauce at the time of filling was in the range of 110 to 130°F. It was not possible to fill the sauce in a higher temperature range due to the high vacuum conditions of the sealing chamber on the Reycon sealer.

The trays were sealed on the Reycon sealer using the following sealing parameters:

Seal Temperature:	360°F
Seal Pressure:	50 psig
Seal Time:	2.00 seconds
Vacuum:	22" - 24" Hg
Chamber Dwell:	4.00 seconds

THERMOPROCESSING

Retort cook cycles for the potatoes au gratin were in the range of 34 to 39 minutes (after retort reached process temperature) at 250° F using steam cooks. The overpressure used was approximately 23 to 24 psig during the cook and 27 to 28 psig during the cool. This added pressure helped decrease strain on the seals in the absence of water. The sterilization requirement for this product was an F₀6.

CHICKEN A LA KING

PREPARATION

The frozen precooked chicken dice was tempered to the range of 28 to 40° F before addition to the sauce.

The starch (3.6 lb) was combined with 10 lb of the broth/water mixture. The slurry was mixed well to dissolve any lumps and set aside for later addition to the sauce.

The remaining chicken broth and water mixture, mushroom brine, chicken fat, and lecithin were added to a 60-gallon, steam-jacketed kettle, heated to boil while mixing vigorously to emulsify the fat into the broth. The dehydrated cream cheese was added and the mixture stirred to completely dissolve the cheese.

The sauce was allowed to cool to 180° F and the remaining ingredients (except the slurry) were added and stirred to uniformly disperse the spices. The slurry was then added and the sauce heated with constant agitation to 180 to 190° F and held in that temperature range for five minutes.

The final volume of the sauce was adjusted with water to compensate for evaporation loss.

The tempered diced chicken was added to the sauce and mixed well for uniform distribution.

FILLING AND SEALING

The product was filled into 10.5-oz DRG trays at 326 g per tray. The filled trays were sealed using the following parameters:

Vacuum: 24" Hg
Seal Temperature: 355° F
Seal Time: 2.00 seconds
Seal Pressure: 45 psig
Chamber Dwell: 4.00 seconds

THERMOPROCESSING

The product was processed in steam cooks at 250° F to the stated sterilization requirement of Fo6. The cook cycles were completed at 42 to 49 minutes after retort reached process temperature.

BEEF STEW

PREPARATION

Thirty lb of water was placed in a 60-gallon, steam-jacketed kettle and heated until it reached 180° F. The raw diced beef (120 lb) was placed in the water and blanched for three minutes. The blanched beef was drained and the broth reserved for use in the sauce.

The percentage yield of the blanched beef ranged from 68% to 79.6%, the average was 73.3%.

A starch slurry was prepared by mixing five lb of the reserved water with two lb of starch. The slurry was set aside for later addition to the sauce.

The remaining water and dry ingredients were combined in the 60-gallon, steam-jacketed kettle and heated to 140° F. The starch slurry was added and heated with constant agitation to not more than 180° and held for five minutes.

The final volume of the sauce was adjusted with water to compensate for evaporation loss.

The carrots, peas, and dehydro-frozen potatoes were added to the sauce along with seven and one-half lb of reserved beef broth. The cooked beef was added, and the product was mixed well to evenly distribute the beef and vegetables.

FILLING AND SEALING

The product was filled into 10.5-oz DRG trays at 326 g per tray. The filled trays were sealed using the following sealing parameters:

Vacuum:	24" Hg
Seal Temperature:	355°F
Seal Time:	2.00 seconds
Seal Pressure:	45 psig
Chamber Dwell:	4.00 seconds

THERMOPROCESSING

The product was processed in steam cooks at 250°F to the stated sterilization requirement of Fo6. The cook cycles were 38 to 50 minutes after retort reached process temperature.

BEEF STRIPS WITH GREEN PEPPERS AND GRAVY

PREPARATION

Raw beef strips (100 lb) were placed in a 60-gallon, steam-jacketed kettle with six lb of water and blanched for 10 minutes. The blanched beef was drained and the broth reserved for use in the sauce. Yield of the blanched beef ranged from 56% to 71.4%, the average was 63%.

A starch slurry was prepared by combining the required amount of starch (1.8 lb per batch) with three lb of the formula water. The prepared slurry was set aside for later addition to the sauce.

All the remaining ingredients were combined in a 60-gallon, steam-jacketed kettle and heated to 140°F. The starch slurry was added, and the sauce was heated (with constant agitation) to the temperature range of 180 to 190°F and held for five minutes.

The final volume of the sauce was adjusted with water to compensate for evaporation loss. The product was filled in two stages, blanched beef strips first followed by gravy.

The proportions of fill are as follows:

<u>Ingredient</u>	<u>Percentage By Weight</u>	<u>Actual Grams</u>
blanched beef	60.37	196.8 g
gravy	39.63	129.2 g
	-----	-----
Total	100.00%	326.0 g

FILLING AND SEALING

The product was filled into 10.5-oz DRG trays and sealed using the following parameters:

Vacuum: 24" Hg
Seal Temperature: 355°F
Seal Time: 2.00 seconds
Seal Pressure: 45 psig
Chamber Dwell: 4.00 seconds

THERMOPROCESSING

The sealed trays were processed in steam cooks at 250°F to the stated sterilization requirement of Fo6. The retort cook cycles were 40-55 minutes after the retort reached process temperature.

SPAGHETTI WITH MEAT SAUCE

PREPARATION

The meat sauce was put together in batches of three sizes--30 lb, 60 lb, and 120 lb. The 30-lb batches were cooked in the five-gallon, steam-jacketed kettle, the larger batches were cooked in the 60-gallon, steam-jacketed kettle.

The ground beef was browned thoroughly. The starch and a portion of the water were slurried and set aside. The remaining ingredients were added to the beef and heated to 180° to 190°F. The starch slurry was added and the sauce held at 180 to 190°F for five minutes with continuous stirring. The sauce was then weighed to determine evaporation loss and the appropriate amount of water was added back to the sauce and stirred to mix. The spaghetti was blanched in boiling water for 6 to 8 minutes in five-lb batches. After blanching, the spaghetti was rinsed in cold water to remove excess starch and weighed to assure that the blanch was sufficient to double the dry weight of the spaghetti.

FILLING AND SEALING

The product was filled in two stages, spaghetti first followed by the meat sauce. The proportions of fill are as follows:

<u>Ingredient</u>	<u>Percentage By Weight</u>	<u>Actual Grams</u>
meat sauce	84.13	275 g
spaghetti, blanched	15.87	52 g
	-----	-----
Total	100.00	326 g

The product was filled into 10.5 oz DRG trays and sealed using the following parameters:

Seal Temperature: 360°F
Seal Pressure: 50 psig
Seal Time: 2.00 seconds
Vacuum: 24"
Chamber Dwell: 4.00 seconds

The sealed trays were processed in steam cooks at 250°F to the stated sterilization requirement of Fo6. The retort cook cycles were 42 to 48 minutes after retort reached process temperature.

RESULTS AND RECOMMENDATIONS

TABULATED SUMMARIES

Tables 1 through 4 summarize the actual and mean results of testing components of retorted meals in coextruded barrier trays.

TABLE I ACTUAL DRY WEIGHTS OF MEAL COMPONENTS

PRODUCT	SAMPLE NUMBER										AVERAGE
	1	2	3	4	5	6	7	8	9	10	
PEANUT RICE	239g	239g	238g	238g	238g	238g	231g	228g	228g	230g	229.0g 8.0 oz
PEACHES	225g	230g	230g	228g	230g	229g	226g	228g	224g	227g	228.1g 8.0 oz
Pears	229g	230g	231g	230g	233g	230g	229g	231g	228g	231g	230.2g 8.1 oz
RICE IN BUTTER SAUCE	230g	229g	230g	230g	230g	230g	231g	230g	228g	229g	229.7g 8.1 oz
POTATOES AU GRATIN	228g	228g	228g	227g	227g	226g	227g	227g	227g	228g	227.3g 8.0 oz
SPAGHETTI W/MEAT SAUCE	326g	327g	325g	326g	325g	326g	327g	325g	326g	326g	326.3g 11.5 oz
BEEF STEW	327g	329g	329g	329g	328g	328g	328g	328g	331g	329g	329.4g 11.6 oz
CHICKEN ALA KING	327g	329g	327g	329g	326g	328g	327g	328g	324g	326g	327.5g 11.5 oz
BEEF STRIPS W/CP	330g	327g	329g	330g	328g	327g	331g	328g	327g	330g	328.7g 11.5 oz
CHOCOLATE PUDDING	253g	253g	252g	252g	252g	251g	251g	251g	252g	251g	251.0g 8.0 oz

TABLE 2 DRAINED WEIGHTS OF MEAL COMPONENTS

PRODUCT	SAMPLE NUMBER										AVERAGE
	1	2	3	4	5	6	7	8	9	10	
PEANUT RICE	149g	154g	146g	149g	152g	147g	148g	147g	148g	148g	149.7g 5.25 oz
PEACHES	148g	137g	156g	136g	138g	132g	134g	136g	140g	136g	138.5g 4.4 oz
Pears	136g	140g	135g	140g	142g	138g	141g	141g	141g	140g	139.4g 4.9 oz
POTATOES AU GRATIN	130.8g	124.8g	124.0g	125.4g	133.3g	126.6g					127.5g 4.5 oz
SPAGHETTI (COMBINED)	215g	204g	216g	212g	215g	210g	212g	199g			210.0g 7.4 oz
BEEF STEW - BEEF	100.8g	120.3g	120.4g	125.4g	118.8g						120.3g 4.2 oz
-VEGETABLES (COMBINED)	103.1g	97.7g	86.6g	101.9g	114.5g						100.0g 3.6 oz
CHICKEN ALA KING (COMBINED)	165.1g	175.1g	176.2g	164.1g	161.9g						160.5g 5.9 oz
BEEF STRIPS - BEEF	183.4g	185.5g	185.4g	159.4g	174.9g	160.8g	180.4g	159.5g			171.0g 6.0 oz
- GREEN PEPPERS	17.2g	20.7g	13.1g	13.8g	28.1g	46.0g	21.1g	25.1g			22.1g .02 oz

TABLE 3 RESULTS OF SALTS AND FATS ANALYSIS ON SPECIFIC MEAL COMPONENTS

PRODUCT	SAMPLE NUMBER											
	1	2	3	4	5	6	7	8	9	10	11	12
BEEF STRIPS:												
SALTS	.60	.60	.79	.68	.60	.60	.50	.59				
FATS	6.7	7.1	5.2	6.6	6.3	6.9	5.7	6.4				
BEEF STEW:												
SALTS	.06	.06	.06	.06	.06	.06	.05	.06	.05	.06	.06	.05
FATS	2.9	2.6	3.1	2.3	3.7	4.0	4.0	5.5	6.7	6.1	6.2	5.5
CHICKEN ALA KING:												
SALTS	1.00	.95	1.00	1.00	.95	1.00	1.00	1.00	1.00	.95	.95	.95
FATS	5.6	6.0	6.0	6.3	6.6	6.0	5.7	5.8	5.6	5.9		
SPAGHETTI:												
SALTS	1.39	1.39	1.24	1.39	1.00	1.00						
FATS	6.5	4.8	4.0	4.2	3.6	4.1						
POTATOES AU GRATIN:												
SALTS	.8	.8	1.0	1.0	.9	1.0	1.2	1.3	1.3	1.2		

TABLE 4 BURST TEST RESULTS OF COEXTRUDED BARRIER TRAYS

PRODUCT	PSI* BURST	COMMENTS
BEEF STRIPS	15	Seals did not give way, lidstock broke at seal ledge.
	13	
CHICKEN ALA KING	17	
	14	
BEEF STEW	10	
	13	
SPAGHETTI	17	
	17	
<hr/>		
POTATOES AU GRATIN	15	Seals gave way.
	15	
FRUIT MIX	22	
	19	
CHOCOLATE PUDDING	21	
	16	
RICE IN BUTTER SAUCE	21	
	23	

*PSI - Pounds per square inch

DISCUSSION OF RESULTS WITH RECOMMENDATIONS

FRUIT PRODUCTS

It is recommended that the fill requirements for the fruit products be changed to a higher fruit to syrup ratio. A higher fill weight in the tray would reduce stress on the lid and seal area by reducing the amount of headspace in the container.

Following are the proposed fill weights:

<u>Product</u>	<u>Percentage By Weight</u>	<u>Actual Grams</u>
Fruit Mix		
fruit	75	192
syrup	25	64
	-----	-----
Total	100%	256 g (9 oz)
Sliced Peaches		
fruit	75	192
syrup	25	64
	-----	-----
Total	100%	256 g (9 oz)
Sliced Pears		
fruit	75	192
syrup	25	64
	-----	-----
Total	100%	256 g (9 oz)

Overall, the fruit products did very well in the package.

CHOCOLATE PUDDING

The net weight of the chocolate pudding should be increased to reduce headspace in the tray. In order to meet the RA requirements of <10cc, a vacuum of at least 24" Hg was required.

Due to the chocolate pudding density, the eight oz net weight of pudding left a larger headspace than the fruit products.

Attempts to fill this product at 150°F and seal under 24" of vacuum failed due to the product "boiling" and contaminating the seal area. Successful seals were obtained after the product temperature dropped to approximately 140°F. The established sterilization requirement of Fo8.5 should be sufficient to render a commercially sterile product if the time between product formulation and processing is kept to a minimum. One option may be to put the product together "cold". This would facilitate sealing and studies would have to be done to determine the effect on the cook cycle (which would be considerably longer with a cold product) and final product quality.

RICE IN BUTTER SAUCE

The rice in butter sauce was acceptable in flavor and texture. The moisture results we obtained were higher than the requirements in the specification. Our results ranged from 59 to 68%, the average was 64.5%.

Samples of this product were sent to the Natick Project Officer, as we had some questions about the formulation and moisture of the product. In her response, she questioned the distortion of the seal ledge of the 8-oz Rampart trays she had received. At that point, we did some experimentation with the sealing parameters and eventually lowered the seal temperature. This eased the distortion to a degree; decreasing the headspace in the containers would also help as that would decrease the pull of the lidstock on the sealed trays.

POTATOES AU GRATIN

The potatoes au gratin was acceptable in both flavor and texture. Again, increasing the net weight slightly and decreasing the sauce temperature at filling would help in sealing the tray.

CHICKEN A LA KING

The chicken a la king looked slightly dark, possibly as a result of the addition of celery and green pepper to the product. It is also thicker than the MRE 7 product and had reduced chicken flavor.

We did not experience any problems in filling, sealing or processing this product.

BEEF STEW

The beef stew appeared very thick. The meat dice tended to break up during processing. The researchers feel utility grade beef from a supplier accustomed to supplying that beef for MRE programs would have held up better in the retort.

The flavor of this product was good and the texture of the vegetable pieces was also good.

BEEF STRIPS WITH GREEN PEPPERS AND GRAVY

The beef strips with green peppers and gravy had a very pleasing appearance, but the green peppers became soft and mushy after rehydration, followed by thermoprocessing. We recommend another form of green pepper be used for production quantities, such as fresh or fresh frozen, and that the beef strips be slightly larger.

Again, the beef was probably not the correct quality for this application. It was difficult to get exactly what we requested in the small amounts we required.

SPAGHETTI WITH MEAT SAUCE

The spaghetti with meat sauce was acceptable in flavor, texture, and appearance. Ideally, this product should be combined and filled at a single stage.

We experienced some difficulty in obtaining drained weights on this product. The small-piece size of the meat made it hard to separate from the spaghetti. Allen Richards of Natick directed us in a telephone conversation on January 5, 1988 to do a combined drained weight with an average of not less than 7.4 oz and with no individual sample less than 6.7 oz. This was done accordingly.

This document reports research undertaken in cooperation with the US Army Natick Research, Development and Engineering Center under Contract No. DAAM60-87-C-0050 and has been assigned No. NATICK/TR-88/060 in the series of reports approved for publication.

APPENDIX

PRODUCT FORMULAS

A-1 FRUIT MIX FORMULA

RAMPART TRAY 8 OZ.

INGREDIENTS	PERCENTAGE BY WEIGHT	WEIGHT IN OZ
FRUIT MIX DRAINED WEIGHT	63.75	5.10
SYRUP	35.86	2.87
ASCORBIC ACID	.39	.03
TOTAL	100.0	8.0

FILLING WEIGHTS:

TWO STAGE FILLING

FRUIT MIX	63.92	5.11
SYRUP	36.08	2.89
	-----	-----
	100.0	8.0

A-2 PEACH SLICES FORMULA

RAMPART TRAY 8 OZ.

INGREDIENTS	PERCENTAGE BY WEIGHT	WEIGHT IN OZ
PEACH SLICES DRAINED WEIGHT	59.8	4.78
SYRUP	40.0	3.20
ASCORBIC ACID	.2	.02
	-----	-----
TOTAL	100.0	8.0

FILLING WEIGHTS:

TWO STAGE FILLING

PEACH SLICES	60	4.8
SYRUP	40	3.2
	---	---
	100	8.0

A-3 PEAR SLICES FORMULA

RAMPART TRAY 8 OZ.

INGREDIENTS	PERCENTAGE BY WEIGHT	WEIGHT IN OZ
PEAR SLICES DRAINED WEIGHT	39.8	4.784
SYRUP	40.0	3.2
ASCORBIC ACID	.2	.016
	-----	-----
TOTAL	100.0	8.0

FILLING WEIGHTS:

TWO STAGE FILLING

PEAR SLICES	59.99	4.799
SYRUP	40.01	3.201
	-----	-----
	100.0	8.0

A-4 CHOCOLATE PUDDING FORMULA

RAMPART TRAY 8 OZ.

INGREDIENTS	PERCENTAGE BY WEIGHT	WEIGHT IN OZ
WATER	58.08	5.111
CREAMER, NONDAIRY DRY	17.00	1.496
SUGAR	16.60	1.460
STARCH WAXY MAIZE-MOD	4.50	.396
COCOA	3.50	.308
SALT, NON-IODIZED	.20	.018
SODIUM-STEAROYL LACTYLATE	.10	.009
VANILLA FLAVOR	.02	.002
	-----	-----
TOTAL	100.0	8.8

A-5 RICE IN BUTTER SAUCE FORMULA

RAMPART TRAY 8 OZ.

SAUCE INGREDIENTS	PERCENTAGE BY WEIGHT	WEIGHT IN OZ
BUTTER	97.0	6.1
LECITHIN	3.0	.2
TOTAL	100.0	6.3

FILLING WEIGHTS:

RICE	92.5	7.4
BUTTER SAUCE	6.3	.504
SALT	1.2	.096
	100.0	8.0

A-6 POTATOES AU GRATIN FORMULA

RAMPART TRAY 8 OZ.

INGREDIENTS	PERCENTAGE BY WEIGHT	WEIGHT IN OZ
WATER	78.96	4.106
DEHYD CHEESE	9.7	.504
MARGARINE	4.12	.214
SHORTENING, VEG MOD	3.92	.204
STARCH	2.36	.123
SALT	.52	.027
ONION POWDER	.33	.017
PEPPER, WHITE	.06	.003
COLBY CHEESE FLAV	.03	.002
	-----	-----
TOTAL	100.0	5.2

FILLING WEIGHTS:

POTATOES, BLANCHED	35.0	2.8
SAUCE	65.0	5.2
	-----	---
	100.0	8.0

A-7 CHICKEN A LA KING FORMULA

DRG TRAY 11.5 OZ.

INGREDIENTS	PERCENTAGE BY WEIGHT	WEIGHT IN OZ
CHICKEN BROTH & WATER	69.2	4.378
STARCH (STA-O-PAQUE)	6.00	.380
CHICKEN FAT	4.33	.274
MUSHROOMS	3.67	.232
PEAS	3.52	.222
CREAM CHEESE (DEHYD.)	2.25	.142
POWDERED VEG. SHORTENING	2.25	.142
PIMENTO, DICED	1.78	.113
ONION, CHOPPED, DEHYRD.	1.77	.112
BRINE FROM MUSHROOMS	1.70	.108
SALT	1.40	.089
MSG	.78	.049
CELERY, SLICED, DEHYRD.	.55	.035
GREEN PEPPER, DICED, DEHYD.	.32	.020
LECITHIN	.32	.020
PEPPER, WHITE, GROUND	.10	.006
BAY LEAVES, GROUND	.05	.003
	-----	-----
TOTAL	100.0	6.325

FILLING WEIGHTS:

CHICKEN, DICED, COOKED	45.0	5.175
SAUCE	55.0	6.325
	-----	-----
	100.0	11.5

A-8 BEEF STEW FORMULA

DRG TRAY 11.5 OZ.

SAUCE PREPARATIONS:

INGREDIENTS	PERCENTAGE BY WEIGHT	WEIGHT IN OZ
WATER	79.85	3.105
STARCH (STA-O-PAQUE)	5.88	.229
TOMATO PASTE	5.88	.229
MARGARINE	4.41	.172
SALT	1.50	.058
SUGAR	.94	.036
ONION POWDER	.59	.023
VEGETABLE PROTEIN, HYDRO	.32	.012
PEPPER, BLACK, GROUND	.24	.009
CELERY SOLUABLE	.18	.007
COLOR, CARMEL	.18	.007
GARLIC POWDER	.03	.001
	-----	-----
TOTAL	100.0	3.888
BEEF, COOKED	40.75	4.686
SAUCE	33.80	3.888
POTATOES, DEHYDROFROZEN	7.50	.862
CARROTS	7.50	.862
PEAS	2.95	.340
BROTH	7.50	.862
	-----	-----
		11.5

A-9 BEEF STRIPS WITH GREEN PEPPERS & GRAVY FORMULA

DRG TRAY 11.5 OZ.

INGREDIENTS	PERCENTAGE BY WEIGHT	WEIGHT IN OZ
BROTH	86.37	3.86
WATER		
STARCH (STA-O-PQAUE)	6.00	.268
SOUP STOCK, DEHYD	3.00	.134
SOY SAUCE	2.75	.123
SALT	.75	.034
SUGAR	.75	.034
PEPPERS, GREEN, DEHYD	.75	
LECITHIN	.25	.011
GARLIC POWDER	.08	.004
PEPPER, BLACK	.05	.002
	-----	-----
TOTAL	100.0	4.47

FILLING WEIGHTS:

BEEF STRIPS	60.38	6.94
PEPPERS, GREEN, DEHYD	.75	.08
GRAVY	38.87	4.47
	-----	-----
	100.0	11.5

A-10 SPAGHETTI WITH MEAT SAUCE FORMULA

DRG TRAY 11.5 OZ.

INGREDIENTS	PERCENTAGE BY WEIGHT	WEIGHT IN OZ
BEEF, GROUND, RAW	32.50	3.146
WATER	30.57	2.959
TOMATOES, CRUSHED	17.23	1.667
TOMATO PASTE	12.70	1.229
PARMESAN CHEESE, GRATE	2.05	.198
SALT	1.25	.121
STARCH, MOD (STA-O-PAQUE)	1.25	.121
ONION, CHOPPED, DEHYD	1.20	.116
SUGAR	.75	.072
GARLIC POWDER	.17	.016
ONION POWDER	.10	.009
OREGANO, GROUND	.10	.009
BASIL, GROUND	.08	.008
PEPPER, RED, GROUND	.03	.003
THYME, GROUND	.01	.001
BAY LEAVES, GROUND	.01	.001
	-----	-----
TOTAL	100.0	9.68

FILLING WEIGHTS:

MEAT SAUCE	84.17	9.68
SPAGHETTI	15.83	1.82
	-----	-----
	100.0	11.5

ABBREVIATIONS

cc	cubic centimeters
EVOH	ethylene vinyl alcohol
RA	residual air
AOAC	Association of Official Analytical Chemists
RAFCO-MRE	Right Away Foods Corporation, Meal, Ready-To-Eat
°F	degrees Farenheit
Hg	mercury
psig	pounds per square inch gauge
Fo	accumulated lethality
MRE	meal, ready-to-eat
oz	ounce(s)
lb	pound
pH	acidity and alkalinity level
g	grams